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OPTIMIZING THE PERFORMANCE OF THERMAL POWER PLANTS

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ABSTRACT
Failure of boiler tubes has been a familiar phenomenon in power plants resulting in unscheduled plant shut down; in consequence, there are heavy losses in industrial production. The failure of boiler tubes appears in the form of bending, bulging, cracking, wearing or rupture, causing leakage of the tubes. The failure can be caused by one or more modes such as overheating, stress corrosion cracking (SCC), hydrogen embrittlement, creep, flame impingement, sulfide attack, weld attack, ash erosion, dew point corrosion, etc. Failure of tubes in Thermal power plant which is a main contributor to power generation plays a major role in forced outage. In India the Ash percentage in coal is very high i.e 40 –45% which is a major contributor in boiler tube failure in thermal power plants. In this paper, outage optimization is done through minimization of ash erosion by the use of coal

INTRODUCTION
Energy needs in India will be increasing day by day. Production of electricity by burning of coal will remain a major source of energy in future, hence timely maintenance of boiler which is a major source of steam for running turbine to generate electricity will remain a major challenge. So as to minimize the boiler outage time it is important to reduce the failure of boiler tubes in thermal power plants. In India Ash erosion is a\ major problem in almost all the thermal power plants so it becomes very important to utilize other mechanisms to minimize the problem. In thermal power plant 70% of tube failures are due to Ash erosion

Factors influencing fly ash erosion in coal-fired boilers are
- The velocity of flue gas
- The temperature of flue gas
- The mineral content in coal
- The change in direction of flue gas
- The arrangement of pressure parts and
- The operation above the maximum conditions design rating or with excess airflow above design rate.

Of these factors, the velocity of flue gas, the temperature of flue gas (ash), and mineral matter in coal are the main influencing factors.

PROBLEM FORMULATION
Fly Ash Erosion Symptoms
Tube experiences metal loss from the OD of the tube. Damage will be oriented on the impact side of the tube. Ultimate failure results from rupture due to increasing strain as tube material erodes away.
Ash Erosion
This may be due to fly ash in flue gases or due to air ingress in the boiler or due to steam from soot blowers. Erosion due to fly ash. This type of erosion is mainly observed in second pass of the boiler, normally affected zones being LTSH/Primary SH & Economizer. Normally, maximum design bulk velocities are of the order of 16 m/sec or less. It has been observed that local velocities in excess of 32m/sec can cause fly ash erosion failures in 10,000 to 50,000 hours.

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Causes of Fly Ash Erosion

Unit	Number of Forced Leakages	Period Hours (PH)	Failure Rate (Number of failures/hr)	Mean Time Between Failures(Hrs)
Unit09(2008)	9	8746.42	0.0010	998.2
Unit09(2009)	24	8757.6	0.0027	362.5

Erosion failures are usually of the "cod-mouth" type with thinned edges.
From numerous studies of erosion, it appears that the most important variables are what may be termed :
A) Systems variables, such as
   a) Flue gas velocity
   b) Angle of impingement,
   c)Size of particle, and
B) Operating variables resulting from
   a)Type of coal burned and
   b)Combustion conditions,

ECONOMICS OF USING WASHED COAL

Coal Washing leads to:
Improvement of PUF
Improvement in Generation
Reduction in Specific coal consumption
Increase in Boiler efficiency
Reduction in smoke (Greenhouse gases) & dusts
Improvement in overall economics
.
The boiler used in Unit 9 which is same as tangentially fired pulverized coal boiler.

The data taken from 210MW thermal power plant (i.e Satpura Thermal Power Plant, Sarni,M.P) for the boiler Unit 9 is as below.

Description	Year 2007-08	Year 2008-09	Year 2009-10	Year 2010-11	Year 2011-12	Year 2012-13	Year 2013-14	Year 2014-15
Gen Capacity(MU)	1839.60	1844.64	1839.60	1839.60	1839.60	1844.64	1839.60	1839.60
Generation (MU)	1416.59	1504.53	1445.63	1360.15	1498.96	1353.75	1318.18	1092.71
Coal Consumption(MT)	1142280	1235898	1210584	116560	1275718	113713	1182065	993615
Aux consumption(MU)	121.07	136.12	128.09	121.93	138.84	122.05	125.21	125.21
Planned outage hrs	1015.24	0	650.10	1107.08	0	1138.00	657.57	1732.40
Forced outage hrs	283.4	403.58	266.42	496.04	349.06	344.23	273.05	517.43

Table 1 Comparison of parameters Boiler Unit 9 for past 8 years

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Table 2 Comparison of failure details of Boiler Unit 9 for past 2 years

The designed efficiency of the 210 MW (for 28% ash)power plant is :

$$\eta_{design} = \frac{(210-17) \times 3600 \times 1000}{(4750) \times 110 \times 4.18 \times 1000} \quad X100 \quad = 31.\%$$

The Present efficiency as availability factor of Unit 09 for 2009 is 82 % and ash content is 42.3% and Calorific value of coal is 3650 Kcal/kg and average coal consumption of Unit 09 for 2014-15 is 153.3 tons/hr and 9 % auxiliary consumption.

$$\eta_{actual} = \frac{(172-15) \times 3600 \times 1000}{(3650) \times 153.3 \times 4.18 \times 1000} \quad X100 \quad = 24.00.\%$$

Hence it shows that the plant actually efficiency is low in for units 9 i.e., 24 % as compared to the designed efficiency ie.31%.

By doing the coal washery the ash % can be decreased to 34 % and keeping the availability factor to 82 %, thus the efficiency of plant will be

$$\eta_{withWashing} = \frac{(172-15) \times 3600 \times 1000}{(4220) \times 123 \times 4.18 \times 1000} \quad X100 \quad = 26.00.\%$$

This shows that the efficiency of plant increases to 26 % I.e 2% increase in actual efficiency is achieved if coal washing is done. From above calculation taking the cost of washing per ton is Rs 120/ton we found that we can save Rs.5516.5 (average of Unit 09) per hr of coal consumption.

COST SAVING BY USING COAL WASHING

Particulars	Unit	RoM(Run of Mine)	Washed Coal with 34% ash
Gross Calorific Value	Kcal/kg	3650	4220
Coal	Ton/hr	153	123
Auxiliary	%	9	8
RoM Coal Cost	Rs/ton	990	990
Washing Cost	Rs/ton	-	90
Coal yield	%	100	92

Table 3: Cost saving by using Coal washing

Unit	Coal consumption for 34% ash(ton/hr) Coal consumption after washing	Cost of washed coal 34%ash (Rs/ton x hr) (taking Rs 990+90/ton)	Coal consumption for 40 % ash (ton/hr) Present coal consumpt	Cost of coal 40% Ash (Rs/ton x hr) (taking 990/ton)	Cost of Coal saved (Rs/ton)
9	123	132840	153	151470	18630

Table 4: Comparison of Cost before & after Coal washing

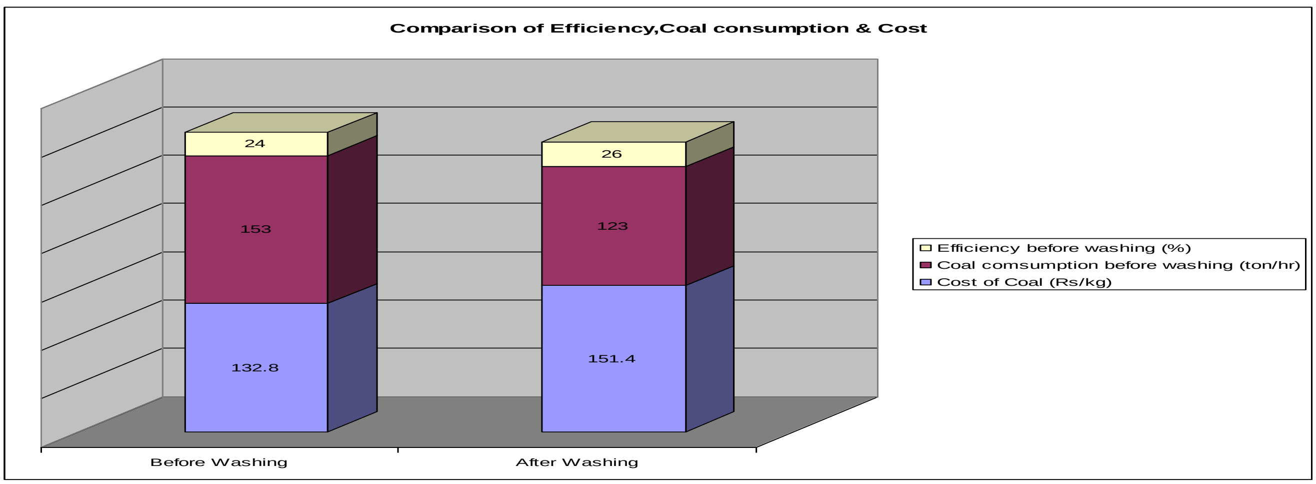

Fig 1: Comparison of cost & coal consumption

CONCLUSION

With help of data taken and tests done on boiler Unit9 of 210MW plant at Satpura Thermal Power Plant,SARNI, we found that the boiler tube failure accounts for nearly 60 to 70 % of total forced outage .

The main contributor to the boiler tube outage is Fly Ash Erosion which is nearly 70 % of total boiler tube leakage. This has also affected the MTBF (Mean Time Between Failure) to decreased to more than 50 % .

With the use of coal washery, the efficiency of plant can be increased by 2% .By using the coal washing the cost of Rs 18.6/kg of coal consumption can be saved.

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